Econometric assessment of production efficiency in textile enterprises

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ABSTRACT

This article discusses the role of textile industries in the global economy, their environmental impact, and the ongoing reforms in the Republic of Uzbekistan in this sector, which is of great importance for both economic and social spheres. Additionally, based on research by foreign specialists in this field, the experiences of textile and clothing production in developed countries have been studied. Furthermore, a multi-factor econometric analysis of changes in production volume was conducted on selected private enterprises from among textile companies operating in the republic, using a statistical sampling method based on the principle of moving from specific to general. The analysis employed t-Statistics, Fisher, Durbin-Watson tests, as well as MAPE and TIC retrospective quality criteria. Conclusions and proposals are presented based on the adequate model verified by these methods.

Keywords: textile products, textile waste, economic efficiency, econometric analysis, correlation, regression.

1. Introduction

Textiles are an important sector of the global economy. In 2019, the turnover of the European Union's textile and garment sector amounted to 162 billion euros, with more than 1.5 million people employed in 160,000 companies. As in many sectors, between 2019 and 2020, the COVID-19 health and economic crisis reduced textile turnover by 9 percent overall and clothing turnover by 17 percent. In 2020, 6.9 million tons of finished textile products were produced in the European Union.[1] Consequently, this sector has a positive impact on addressing issues such as enhancing the competitiveness of developed

countries' economies, introducing scientific and technological advancements into production, creating new jobs, and increasing household incomes. Therefore, this sector has a positive impact on addressing issues such as enhancing the competitiveness of the economies of developed countries, introducing scientific and technological advancements into production, creating new jobs, and increasing household incomes.

In the global economy, the textile industry is defined as the main value chain in the circular economy action plan. In 2020, approximately 175 million tons of primary raw materials were used to produce all clothing, footwear, and household textiles purchased by households in the EU, representing 391 kilograms per person, of which approximately 40% is clothing, 30% is household textiles, and 30% is footwear. From a safety perspective, developing design principles and measures to reduce the negative impact of the textile industry on the environment and climate, as well as increasing circularity in the textile industry, is of great importance in addressing problems aimed at improving the sector's efficiency.

Currently, the textile and garment industry in the Republic of Uzbekistan is growing year after year, and its export potential is increasing. In fact, it has become the leading sector in the structure of the manufacturing industry (in 2021, textiles accounted for 13.7% compared to 13.6% for food production). Certainly, these factors are beneficial for the textile industry of the Republic of Uzbekistan in the long term. Another characteristic of this industry's development can be seen in the availability of raw materials and sufficient labor potential in the republic.

In recent years, comprehensive measures have been implemented to develop the textile, garment-knitwear, leather-footwear, and fur industries within the light industry sector of the republic, expand the types and assortment of finished products, and provide comprehensive support for the investment and export activities of enterprises in the industry. These measures include the resolution "On measures to further develop the light industry and stimulate the production of finished products"[2]. Additionally, to ensure systematic work aimed at further deepening the restructuring of the republic's textile and garment-knitwear industry, the resolution "On measures to further deepen the reform of the textile and garment-knitwear

industry and expand its export potential"[3] was adopted. This resolution focuses on ensuring high and stable growth rates, attracting and utilizing direct foreign investments, producing and exporting competitive products, creating high-tech jobs through the implementation of strategically important modernization projects, technical and technological renovation of enterprises, and further implementing the advanced "cluster model."

2. Materials and Methods

According to H.Y. Li, H.L. Lin, and C.H. Yang, the most important feature of the textile industry's development is its role in ensuring national security, as industrial products are used not only to meet the population's clothing needs but also serve as an important resource for the automotive industry, aircraft manufacturing complex, agriculture, and the military-industrial complex.[4]

The role of the textile industry in industrialization has been emphasized by many foreign authors. It is noted that the textile industry was one of the first sectors where the Industrial Revolution began.[5] A number of contemporary studies substantiate the importance of this industry in industrializing the economies of various countries.[6] At the same time, the experience of developed countries shows that at the stage of import-substituting industrialization, the textile industry serves as a testing ground for innovation. A number of contemporary studies substantiate the importance of this industry in industrializing the economies of different countries.[6] At the same time, the experience of developed countries shows that at the stage of import-substituting industrialization, the textile industry serves as a testing ground for innovation.

Globally, the textile industry is often viewed as a polluting industry that has a serious negative impact on the environment:

- Consumption of large amounts of resources (natural and synthetic fibers, chemicals, and especially water);
- Generation of a large amount of solid and liquid waste.

In this context, for every 80 billion kilograms of textiles produced annually, 10 kilograms of CO_2 are released per kilogram of textile products. As a result, the global textile industry accounts for 10% of CO_2 emissions. Nearly 85 percent of all discarded textile products in the United States - an estimated 13 million tons in 2020 - are sent to landfills or incinerated. The average American discards about 37 kg of clothing each year, and globally, approximately 92 million tons of textile waste are generated annually. Every second, a garbage

truck full of clothing ends up in a landfill. By 2030, we are expected to discard over 134 million tons of textile products per year.[7]

As an ever-growing industry, all research is focused on building a circular economy cluster[8]; studying the conditions for industrial development and constructing a circular economy to address the problem of resource scarcity[9]; examining the formation of interactions between all links in the supplier-buyer chain, a micro-level chain to calculate the amount of materials used in recycling[10]; as well as approaches to using established technologies for designing technological systems for the utilization of textile waste in the chemical industry under the conditions of a new circular economy[11].

In this article, we attempted to focus on the development of the textile industry, its place and role in the national economy through a historical analysis of quantitative and qualitative data on the capital-labor ratio of the textile industry and labor productivity parameters in textile production, as well as existing research on development prospects. The application of an approach based on the analysis of historical data made it possible to obtain new information about the specific features of industrial development, to reconstruct information about the level of production and the significance of state management in production during the process of economic development.

2.1. Spatial Big Data

Within the scope of the topic, a dataset of variables for the years 2010-2021 was created based on initial information gathered. This dataset includes statistical values of production volumes from global textile industry enterprises, the environmental impact of textile industry production, and factors selected based on their correlation with textile enterprise production.

2.2. Research Methods

The study initially utilized a statistical database to conduct an economic and statistical analysis of the ongoing reforms in the textile industry of the Republic of Uzbekistan. Furthermore, to transition from specific to general (micro-level to macro-level) analysis, the research employed econometric analysis methods on statistically sampled data from "Posco International Textile" LLC and "OSEANA textil" LLC to evaluate their effectiveness.

3. Results

3.1. Results of Economic and Statistical Analysis

One of the main goals of our country's economy is to ensure sustainable development, efficiently utilize modern technologies

and resources in production, and organize production processes in accordance with a market economy. As in other sectors, it is difficult to imagine the development of the textile industry and the production of competitive products without using new and modern approaches and taking into account factors that influence production.

Looking at the history of the textile industry's emergence and its development process up to the present day, it is evident that this process is directly linked to the advancement of science and technology, as well as several other factors. To develop the textile industry and achieve high efficiency in the production process, it is necessary to consider numerous factors. In the context of the Republic of Uzbekistan, it can be observed that the production of textile and clothing products in the industry has achieved positive results over the years due to the utilization of available raw materials and opportunities in the country (Figure 1).

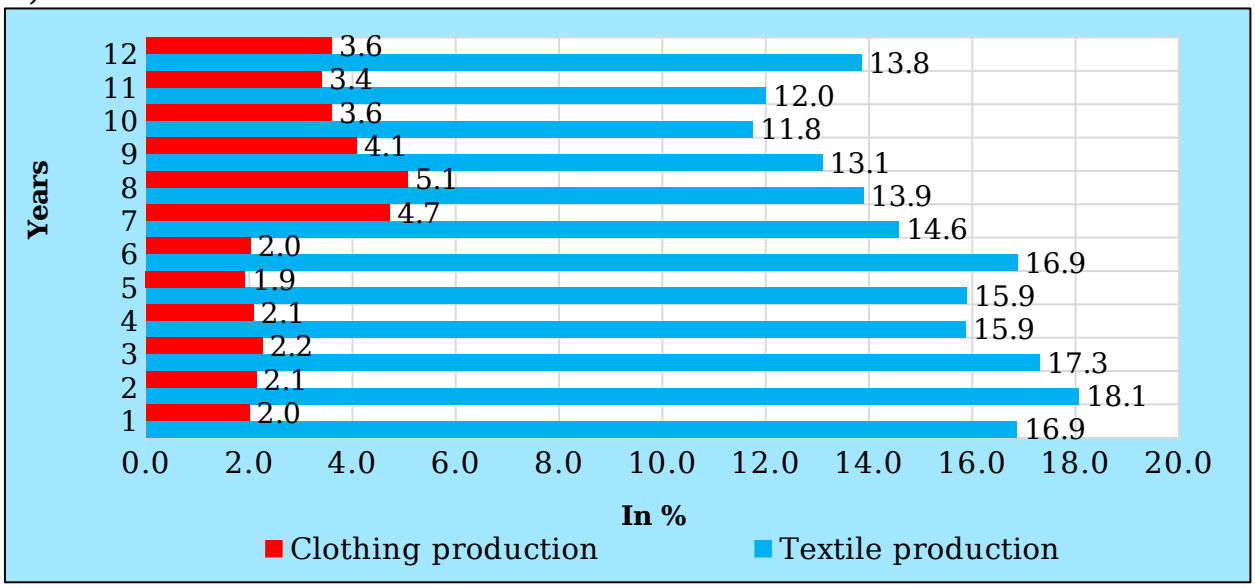

Fig. 1. Share of textile and apparel production in the industry of the Republic of Uzbekistan.

Figure 1 shows the share of textile and clothing production in the industry from 2010 to 2021. According to this, the highest share of textile products in industrial production was 18.1% in 2011, which increased by 1.2% compared to 2010. To achieve such a positive result, the Decree of the President of the Republic of Uzbekistan "On Priority Directions for the Development of Industry in the Republic of Uzbekistan" defined:

- diversification of production, ensuring sustainable growth of export potential based on deep and high-quality processing of local raw materials, increasing production of export-oriented competitive industrial products, and expanding markets for their sale;

- further development of domestic industrial cooperation and localization of production, creating conditions for the accelerated development of small business and private entrepreneurship in industrial sectors, placement of industrial enterprises in all regions of the country and on this basis, production of import-substituting products, creation of new jobs and growth of employment, further increase of incomes and living standards of people;

- consistently increasing industrial production efficiency by increasing labor productivity, consistently reducing production costs and product costs, introducing modern energy and resource-saving technologies, improving production organization, and eliminating losses and unproductive expenses.

It should be noted that by 2021, the share of textile products in the industry of the Republic of Uzbekistan decreased by 3.1 percentage points compared to 2010 and amounted to 13.8 percent, which is explained by the increase in the volume of production of other industrial products in the republic. In particular, the metallurgical industry increased by 12.8 percentage points compared to 2010, reaching 25.6% in 2021, electrical equipment production increased by 0.5 percentage points to 1.2%, and clothing production grew by 1.6 percentage points, amounting to 3.6%.

The results of the analysis show that such a significant increase in clothing production was due to the rise in prices for imported goods and the increase in demand for local goods in our country due to some changes in legislation. The raw material base of the textile industry has also significantly changed over the past years, as the share of natural fibers has decreased, while the share of chemical fibers, especially synthetic fibers, has increased, which has allowed for the expansion and strengthening of the raw material base of the textile industry.

3.2. Results of Econometric Analysis

It should be noted that generalizing scientific approaches to determining the effectiveness of enterprise activities allows for assessing the effectiveness of all enterprises at the macroeconomic level based on various criteria. Based on these considerations, we will conduct an econometric analysis of the effectiveness of "Posco International Textile" LLC and "OSEANA textil" LLC, which are currently achieving high results in organizing economic activities, developing and improving weaving and spinning production processes in the Fergana region as a result of rational policies chosen for the study.

For this purpose, using data obtained from the reports of both enterprises for 2010-2022, factors strongly influencing the change in the enterprise's production volume (KIH) were selected: the level of raw material supply of the enterprise (XTD), the number of employees working at the enterprise (KIS), and the value of fixed assets at the enterprise (AVQ). First, let's consider an econometric analysis of the factors influencing changes in the production volume of "OSEANA textil" LLC. To do this, the correlation coefficient between these selected factors is determined (Table 2).

Table 2

Correlation coefficients of factors affecting changes in production volume of "OSEANA textil" LLC.

	EPV	*RMS*	*NEE*	*VFA*
KIH	1			
XTD	0,969228	1		
KIS	0,878624	0,679732	1	
AVQ	0,960176	0,7061	0,572632	1

If we examine the values in the table, we can see that the production volume of "OSEANA textil" LLC is strongly and positively correlated with the company's level of raw material supply - RMS ($r_{EPV,RMS=0.969228}$), the number of employees working at the enterprise - NEE ($r_{EPV,NEE=0.878624}$), and the value of fixed assets in the company - VFA ($r_{EPV,VFA=0.960176}$). There is no multicollinearity between the factors according to the condition $r_{x1,x2}<0.8$. This indicates that the influencing factors have been correctly selected and that the subsequent process can be continued.

Moreover, the relationship between the factors influencing the resulting factor is a direct one, meaning that an increase in these factors leads to an increase in the resulting factor. To determine the regression equation for the observed relationships, we will logarithmically transform the factors using base e and continue the process using the EViews program (Table 3).

Table 3

Multi-factor regression equation for the production volume of "OSEANA textil" LLC.

Dependent Variable: LNKIH
Method: Least Squares
Date: 09/17/23 Time: 15:12
Sample: 2010 2022
Included observations: 13

Variable	Coefficie	Std. Error	t-Statistic	Prob.

	nt			
	5.93706			
LNRMS	5	3.142351	1.889370	0.0094
	3.13670			
LNNEE	1	12.77201	0.245592	0.0415
	0.91574			
LNVFA	1	0.396507	2.309520	0.0311
	-47.4088			
C	5	76.57094	-0.619149	0.0503
		t_{tab}=	-1.833113	
	0.95363			10.3151
R-squared	6	Mean dependent var		1
Adjusted R-squared	0.93818 2	S.D. dependent var		0.63951 4
				-0.59211
S.E. of regression	0.15900 4	Akaike info criterion		5
				-0.41828
Sum squared resid	0.22754 0	Schwarz criterion		4
				-0.62784
	7.84874			5
Log likelihood	6	Hannan-Quinn criter.		1.96593
	61.7058			2
F-statistic	1	Durbin-Watson stat		
	0.00000			
Prob(F-statistic)	3	F_{tab}=	0.258896	

Based on the calculation results obtained in the table and using the values from the coefficient column presented in Table 3, the following equation is derived:

$$LnEPV = 5{,}94\,LnRMS + 3{,}14\,LnNEE + 0{,}92\,LnVFA - 47{,}40885 \qquad (1)$$

If we consider the significance of the parameters in the first regression equation according to t-statistic criteria, with α=0.05 and df=9, t_{Tab}=|-1.833113|, we find that the level of raw material supply of the enterprise - RMS (t_{RMS}=1.88937) and the value of fixed assets in the enterprise - VFA (t_{VFA}=2.30952) are significant. However, based on the condition $t_{Tab}<t_{calc,}$ only the parameter for the number of employees working in the enterprise turns out to be insignificant. Nevertheless, considering that all these parameters are important according to p=0.05, it is necessary to verify whether this factor is actually significant or insignificant using retrospective quality criteria MAPE<10% (Mean Absolute Percentage Error) and TIC<1 (Theil Inequality Coefficient - an alternative measure of forecast accuracy) (Figure 4).

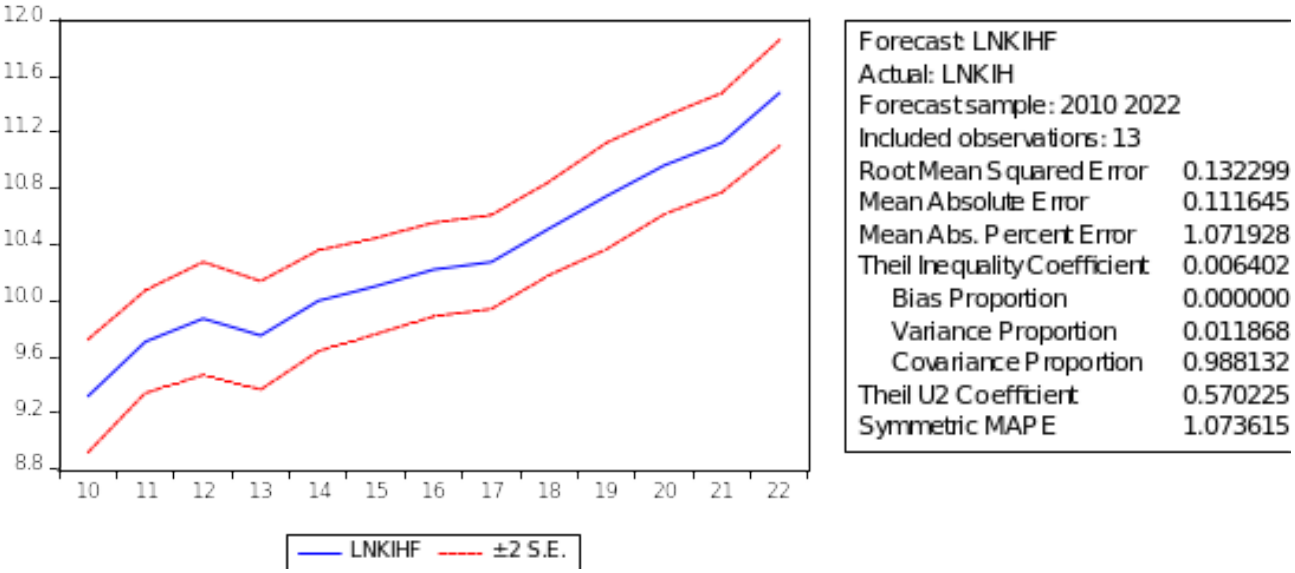

Fig. 4. Results of retrospective quality criteria for regression parameters 1.

Based on the data presented in Figure 4, it can be noted that the MAPE (Mean Absolute Percentage Error) is 1.072, which indicates a high accuracy as MAPE=1.072<10%. Additionally, the TIC (Theil Inequality Coefficient) of 0.0064<1 approaches zero, suggesting that all parameters of the first regression equation are significant. To simplify the calculation process and achieve accurate results, based on the properties of logarithms, the first regression equation obtained above is exponentiated, resulting in the following equation:

$$EPV=\frac{RMS^{5,94}*NEE^{3,14}*VFA^{0,92}}{e^{47,40885}} \qquad (1^*)$$

Given that the actual value of the identified 1*-regression equation is F_{Tab}=0.258896 at α=0.05 and k1=9; k2=3, and the calculated Fisher value is F_{calc}=61.70581, which satisfies the condition $F_{Tab}<F_{calc}$, the significance of the 1*-regression equation is confirmed. Furthermore, it was determined that there is no autocorrelation due to DW=1.965932. Consequently, the equation was found to be reliable and adequate.

If we interpret this identified (1*) regression equation from an economic perspective, it has been determined that if the enterprise's level of raw material supply, number of workers, and value of fixed assets are each increased separately by 1.0%, then the production volume of "OSEANA textil" LLC will correspondingly increase by an additional 7,128.4 million soums, 3,715.7 million soums, and 1,076.0 million soums respectively. This, in turn, indicates the extensive potential of "OSEANA textil" LLC and the necessity to develop measures aimed at increasing all selected factors as swiftly as possible. For this purpose, in our opinion, it is primarily essential to constantly monitor the

enterprise's level of supply with raw materials and material resources, for which the following is necessary:

- studying the calculation procedures and durations of contracts for the supply of material resources, as well as the terms of delivery;
- determining the nature of production material reserves and changes in their composition;
- verifying the validity of production reserve norms and the requirements for material resources;
- identifying opportunities to reduce production reserves and material resource needs, as well as developing measures to reduce excess material reserves.

To develop the company's activities, it is necessary to create the following personnel policy strategy:

- utilizing all socio-economic factors that influence employees, particularly methods such as incentives, motivation, and improvement of working conditions;
- concluding contracts with promising new employees (at the employer's request - for a specified term);
- providing company employees with opportunities for higher or specialized education or professional development (by the employer's decision). Under such a strategy, the manager always has the opportunity to offer employees certain socio-economic benefits that they can receive to increase production volume.

Now, using the data from "Posco International Textile" LLC, the enterprise's production volume (EPV) is selected as the resulting factor. Factors strongly influencing the change in EPV are identified as the enterprise's production capacity (EPC), the number of employees working at the enterprise (NEE), and the value of fixed assets at the enterprise (VFA). The correlation coefficient between these factors is determined (Table 5).

Table 5

Correlation coefficients of factors affecting changes in production volume of "Posco International Textile" LLC.

	EPV	*EPC*	*NEE*	*VFA*
EPV	1			
EPC	0,962262	1		
NEE	0,838209	0,764211	1	
VFA	0,914138	0,695666	0,762584	1

According to the data in the table, the production volume of "Posco International Textile" LLC is strongly and positively correlated with the enterprise's production capacity - EPC ($r_{EPV,EPC}$=0.962262), the number of employees working at the enterprise - NEE ($r_{NEE,NEE}$=0.838209), and the value of fixed

assets at the enterprise - VFA ($r_{EPV,\ VFA}$=0.914138). An increase in these selected factors leads to an increase in the resulting factor. There is no multicollinearity between the influencing factors according to the condition $r_{x1,x2}$<0.8.

Based on the verification results, the selected factors have been chosen correctly. Since the units of measurement for the factors differ in determining their regression equation, the process can be continued using the EViews program by logarithmically transforming them to the base e to bring them to a uniform scale (Table 6).

Table 6

Multi-factor regression equation for the production volume of "Posco International Textile" LLC.

Date: 09/18/23 Time: 07:17
Method: Least Squares
Date: 09/18/23 Time: 07:17
Sample: 2010 2022
Included observations: 13

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEPC	10.90338	4.800285	2.271402	0.0493
LNNEE	1.447106	0.742569	1.948783	0.0213
LNVFA	0.075657	0.086732	0.872302	0.0405
C	-57.9456	20.07575	-2.886345	0.0182
R-squared	0.939823	Mean dependent var		3.558848
Adjusted R-squared	0.919764	S.D. dependent var		0.299500
S.E. of regression	0.084836	Akaike info criterion		-1.848532
Sum squared resid	0.064774	Schwarz criterion		-1.674702
Log likelihood	16.01546	Hannan-Quinn criter.		-1.884262
F-statistic	46.85310	Durbin-Watson stat		2.058804
Prob(F-statistic)	0.000008			

Based on the calculations conducted using the EViews program, the following equation is derived from the values presented in the coefficient column of Table 6:

$$LnEPV = 10{,}9\,LnEPC + 1{,}45\,LnNEE + 0{,}08\,LnVFA - 57{,}946 \qquad (2)$$

If we focus on the significance of the parameters of the identified 2-regression equation according to the t-Statistic criteria, then for $\alpha=0.05$ and df=9, given that $t_{Tab}=|-1.833113|$, the parameters for the degree of utilization of the enterprise's production capacity - EPC ($t_{EPC}=2.271402>t_{Tab}=|-1.833113|$) and the number of workers employed at the enterprise - NEE ($t_{NEE}=1.948783>t_{Tab}=|-1.833113|$) are significant. This implies that only the parameter for the value of fixed assets at the enterprise is insignificant. However, according to p=0.05, considering that all of these parameters are important, it is necessary to verify whether this factor is actually significant or insignificant using the retrospective quality criteria MAPE<10% and TIC<1 (Figure 7).

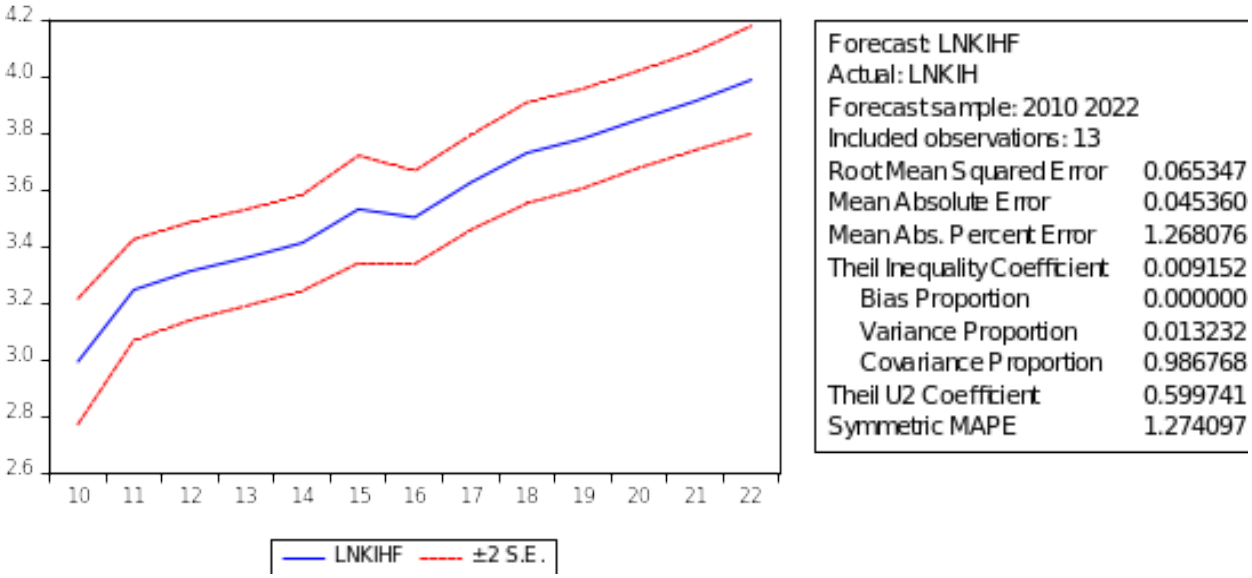

Fig. 7. Results of retrospective quality criteria for regression parameters 2

According to the data in Figure 7, it can be noted that MAPE = 1.268, which in turn implies the fulfillment of inequalities MAPE = 1.268 < 10% and TIC = 0.0092 < 1, indicating the significance of all parameters in the second regression equation. Based on the properties of logarithmic functions, the second regression equation generated above is exponentiated, and as a result, the following equation is formed:

$$EPV=\frac{EPC^{10,9}*NEE^{1,45}*VFA^{0,08}}{e^{57,946}} \qquad (2^*)$$

The significance of the obtained 2*-regression equation can be confirmed, considering that at α=0.05, k1=9, and k2=3, the tabulated Fisher value F_{Tab}=0.258896, while the calculated Fisher value is F_{calc}=46.8531. Since $F_{Tab}<F_{calc}$, the 2*-regression equation is significant. Furthermore, with DW=2.059, there is no autocorrelation present, indicating that the equation is reliable and adequate.

If we economically substantiate equation (2*) determined as a result of the research, it was found that if the production capacity of the enterprise, the number of workers at the enterprise, and the value of fixed assets at the enterprise are each increased separately by 1.0%, then the production volume of the textile enterprise "POSCO INTERNATIONAL" LLC will additionally increase by 5.8 million soums, 0.7 million soums, and 0.1 million soums, respectively.

Based on the results of the econometric analysis conducted at both enterprises, it should be emphasized that both enterprises have well-established management strategies, and it is advisable to organize reserves of raw material resources and

implement rational use of labor force in addition to their ongoing work processes.

4. Discussion

The textile and apparel industry in the Republic of Uzbekistan faces several challenges, including high energy costs and supply disruptions, inadequate transformation infrastructure, and outdated textile machinery. Moreover, the influx of illegal textile products into the domestic market further aggravates these issues. Research findings indicate that currently, illegal textile products constitute over 50 percent of the global textile market, accounting for 1,013 tons.

To enhance the productivity and competitiveness of the industry, efforts are needed to improve the performance of this sector through increased efficiency. It is anticipated that the products of Uzbekistan's textile and clothing industry will be able to compete with those from other countries. This, in turn, will encourage industrial expansion, market growth, and an increase in labor-intensive production.

Determining the effectiveness of an enterprise's activities has significant scientific and practical importance. It not only allows for assessing the enterprise's efficiency and analyzing the overall effectiveness of its various structural units and areas of activity but also helps in formulating development strategies, forecasting the results of future resource utilization (particularly production tools, labor, and information), and developing action plans. To determine this, it is necessary to apply a comprehensive approach that incorporates a set of criteria for evaluating the enterprise's effectiveness, including cost efficiency, targeted efficiency, and competitiveness.

5. Conclusion

In this study, we examined the institutional basis as a crucial factor in the development of the textile industry in the Republic of Uzbekistan. This basis is characterized by a system of legislative and regulatory documents, as well as a framework of formal and informal institutions that stimulate the growth of the textile industry. In this context, it is essential to understand the institutional foundations of regional industrial policy, particularly its essence, to effectively describe its sectoral component. The results of our research and analysis enable the systematization of a set of goals and factors for implementation, aimed at achieving organic, dynamic, competitive, and balanced development in both the territorial and sectoral aspects of regional industrial policy.

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